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Neutron-Capture Elements in Halo, Thick-Disk, and Thin-Disk Stars: Neodymium

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Abstract

We have derived the LTE neodymium abundances in 60 cool stars with metallicities [Fe/H] from 0.25 to -1.71 by applying a synthetic-spectrum analysis to spectroscopic observations of NdII lines with a resolution of $\lambda/\Delta\lambda \simeq 60000$ and signal-to-noise ratios of 100-200. We have improved the atomic parameters of NdII and blending lines by analyzing the corresponding line profiles in the solar spectrum. Neodymium is overabundant with respect to iron in halo stars, [Nd/Fe] = 0.33 ± 0.09, with the [Nd/Fe] ratio decreasing systematically with metallicity when [Fe/H] > -1. This reflects an onset of efficient iron production in type I supernovae during the formation of the thick disk. The [Nd/Ba] and [Nd/Eu] abundance ratios behave differently in halo, thick-disk, and thin-disk stars. The observed abundance ratios in halo stars, [Nd/Ba] =0.34 ± 0.08 and [Nd/Eu] = -0.27 ± 0.05, agree within the errors with the ratios of the elemental yields for the r-process. These results support the conclusion of other authors based on analyses of other elements that the r-process played the dominant role in the synthesis of heavy elements during the formation of the halo. The [Nd/Ba] and [Nd/Eu] ratios for thick-disk stars are almost independent of metallicity ([Nd/Ba] = 0.28(±0.03)-0.01(±0.04) [Fe/H] and [Nd/Eu] = -0.13(±0.03) + 0.05(±0.04) [Fe/H]) but are smaller in absolute value than the corresponding ratios for halo stars, suggesting that the synthesis of s-process nuclei started during the formation of the thick disk. The s-process is estimated to have contributed ≃30% of the neodymium produced during this stage of the evolution of the Galaxy. The [Nd/Ba] ratio decreases abruptly by 0.17 dex in the transition from the thick to the thin disk. The systematic decrease of [Nd/Ba] and increase of [Nd/Eu] with increasing metallicity of thin-disk stars point toward a dominant role of the s-process in the synthesis of heavy elements during this epoch. © 2004 MAIK "Nauka/Interperiodica".

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